# PLANAR HINGE ASSEMBLY

## CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims the benefit of U.S. Provisional Application No. 62/731,254, entitled "PLANAR HINGE ASSEMBLY," filed Sep. 14, 2018, the content of which is incorporated herein by reference in its entirety for all purposes.

## FIELD

The following disclosure relates to an electronic device. In particular, the following disclosure relates to a bending structure in an electronic device that is compliant, adjustable and provides variable applied stiffness.

## BACKGROUND

Portable electronic devices are known to include a housing and a cover glass that combines with the housing to enclose components such as a circuit board, a display, and a battery. Also, portable electronic devices are known to communicate over a network server to send and receive information, as well as communicate with a network carrier to send and receive voice communication.

## SUMMARY

This paper describes various embodiments related to an adjustable bending structure in a portable electronic device. Specifically, the adjustable bending structure includes a stack of layers that can transition from an uncompressed state to a compressed state.

In one aspect, a personal computing device comprises a single piece body having a seamless overall appearance and that includes a bendable portion that is capable of having a smoothly curved shape. The single piece body includes a first part capable of carrying a display suitable for presenting visual content, and a second part that is capable of carrying an input device suitable for accepting an input action. The personal computing device also includes a multi-state planar hinge assembly carried by the single piece body at the bendable portion and positioned between and in mechanical communication with the first part and the second part. The multi-state planar hinge assembly includes a planar assembly that, in a first state, is characterized as having a first thickness and allows relative movement of the first and second parts with respect to each other. In a second state, the planar assembly is characterized as having a second thickness, less than the first thickness, that is capable of maintaining a fixed angular displacement between the first and second parts.

In another aspect, a portable electronic device is described. The portable electronic device can include a first part that carries a visual display for presenting visual content, a second part that carries an input device, and a solid-state hinge assembly coupled to the first and second part in a manner that allows relative angular movement between the first and second parts. The solid-state hinge assembly can include a bending medium capable of (i) bending in response to an applied force and (ii) providing a resistance to movement in accordance with an amount of bending, and a force actuator physically coupled to the bending medium, the force actuator capable of providing the force.



Further, a method carried out by operating an adjustable bending structure including a stack of layers is described. The stack of interleaved layers can include material capable of bending in response to an applied force. The adjustable bending structure can be in communication with a sensor capable of detecting a shape of the stack and providing a signal, and can be in communication with an actuator capable of receiving the signal and responding by applying a controller force that controls a shape of the stack. A first controller force can correspond to a first shape and a second controller force can correspond to a second shape. The method includes the actuator receiving a first signal provided by the sensor. The first signal can correspond to the first controller force. Subsequently, the actuator can apply the first controller force to the stack in accordance with the first signal, and the first controller force causes the stack to take on the first shape. Next, the actuator can receive a second signal provided by the sensor. The second signal can correspond to the second controller force. Thereafter, the actuator can apply the second controller force to the stack in accordance with the second signal, and the second controller force causes the stack to take on the second shape that is different from the first shape.

Other systems, methods, features and advantages of the embodiments will be, or will become, apparent to one of ordinary skill in the art upon examination of the following figures and detailed description. It is intended that all such additional systems, methods, features and advantages be included within this description and this summary, be within the scope of the embodiments, and be protected by the following claims.

## BRIEF DESCRIPTION OF THE DRAWINGS

The disclosure will be readily understood by the following detailed description in conjunction with the accompanying drawings, wherein like reference numerals designate like structural elements, and in which:

FIG. **1**A shows a cross sectional view of a stiffness modulator according to a first embodiment in an uncompressed state;

FIG. **1**B shows a magnified cross sectional view of layers in the stiffness modulator of FIG. **1**A;

FIG. **2**A shows a cross sectional view of the stiffness modulator according to the first embodiment in a compressed state;

FIG. **2**B shows a magnified cross sectional view of the layers in the stiffness modulator of FIG. **2**A;

FIG. **3**A shows a stiffness modulator according to a second embodiment in a laptop-computing device;

FIG. **3**B shows a cross sectional view A-A of the laptop-computing device of FIG. **3**A;

FIG. **4**A shows a stiffness modulator according to a third embodiment in a portable electronic device;

FIG. **4**B shows a magnified view of the stiffness modulator of FIG. **4**A;

FIGS. **5**A-**5**D show a stiffness modulator according to a fourth embodiment in different configurations of a portable electronic device;

FIG. **6** is a block diagram of an electronic device suitable for use with the described embodiments;

FIG. **7**A shows a stiffness modulator according to a fifth embodiment being an electronic device in an active state;

FIG. **7**B shows the electronic device of FIG. **7**A in a dormant state;